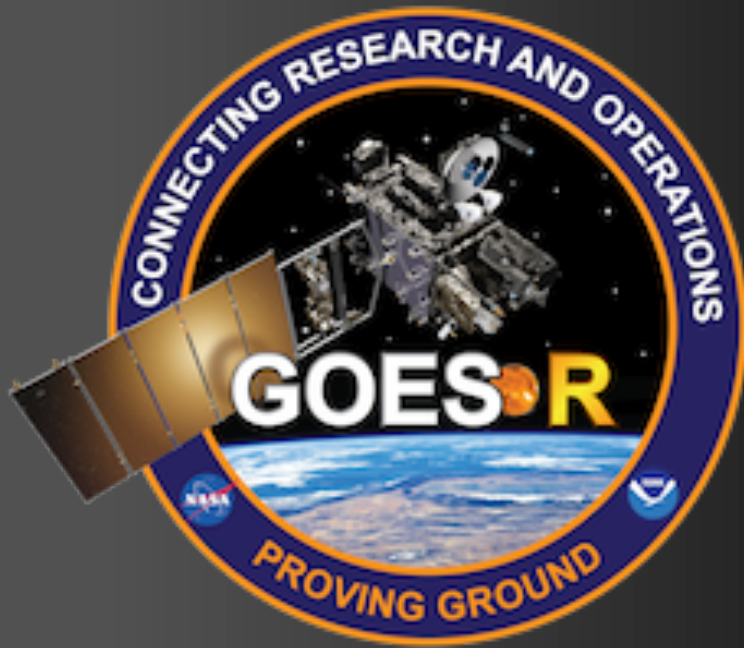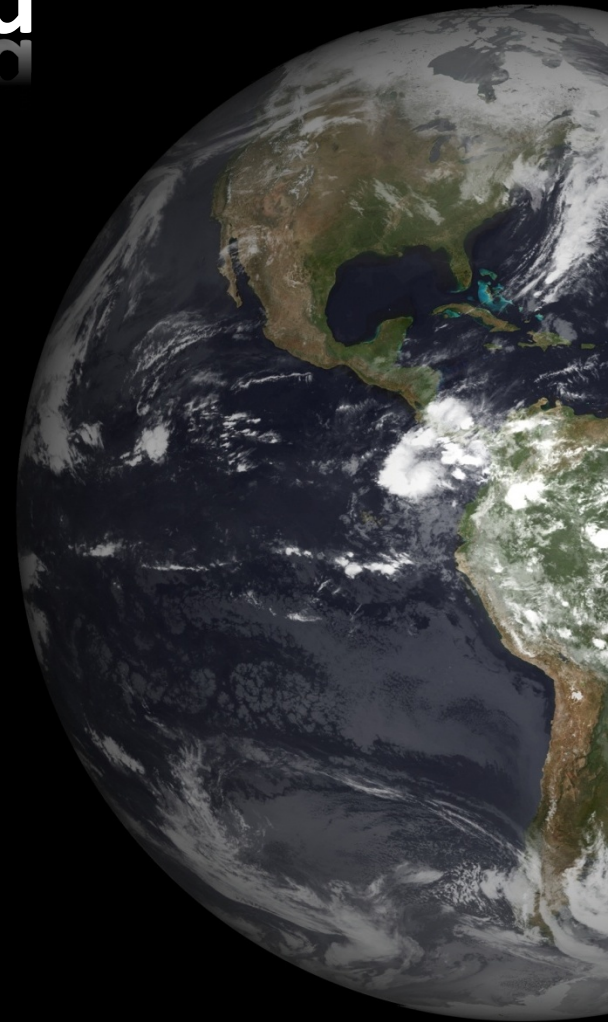# The GOES-R Proving Ground

Steve Goodman and Jim Gurka

GOES-R Program Office

NOAA 3rd Testbed Workshop

Boulder, CO

May 1-3, 2012

Contributors

Timothy Schmit, Mike Pavolonis, Mark DeMaria and Daniel Lindsey
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, Richard Blakeslee, John
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SPoRT
) Center, Huntsville, AL

Gary Hufford
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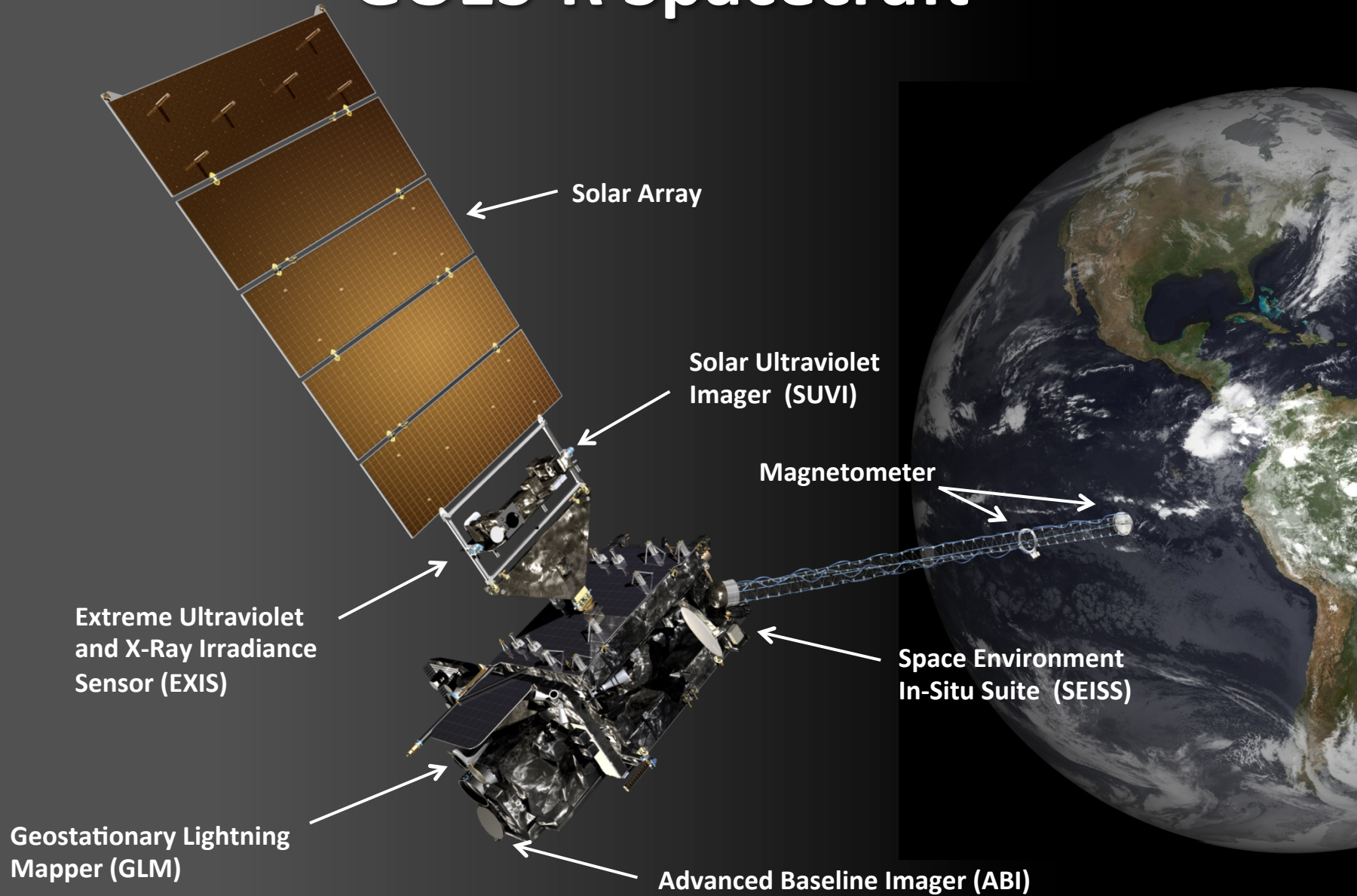Director, NOAA/NWS/Storm Prediction Center, Norman, OK

Outline

– What is the GOES-R Proving Ground?

– Proving Ground Governance

– Examples of GOES-R Proxy Products tested at:

  • HWT Spring Experiment

  – Proving Ground Governance

– Examples of GOES-R Proxy Products tested at:

• HWT Spring Experiment
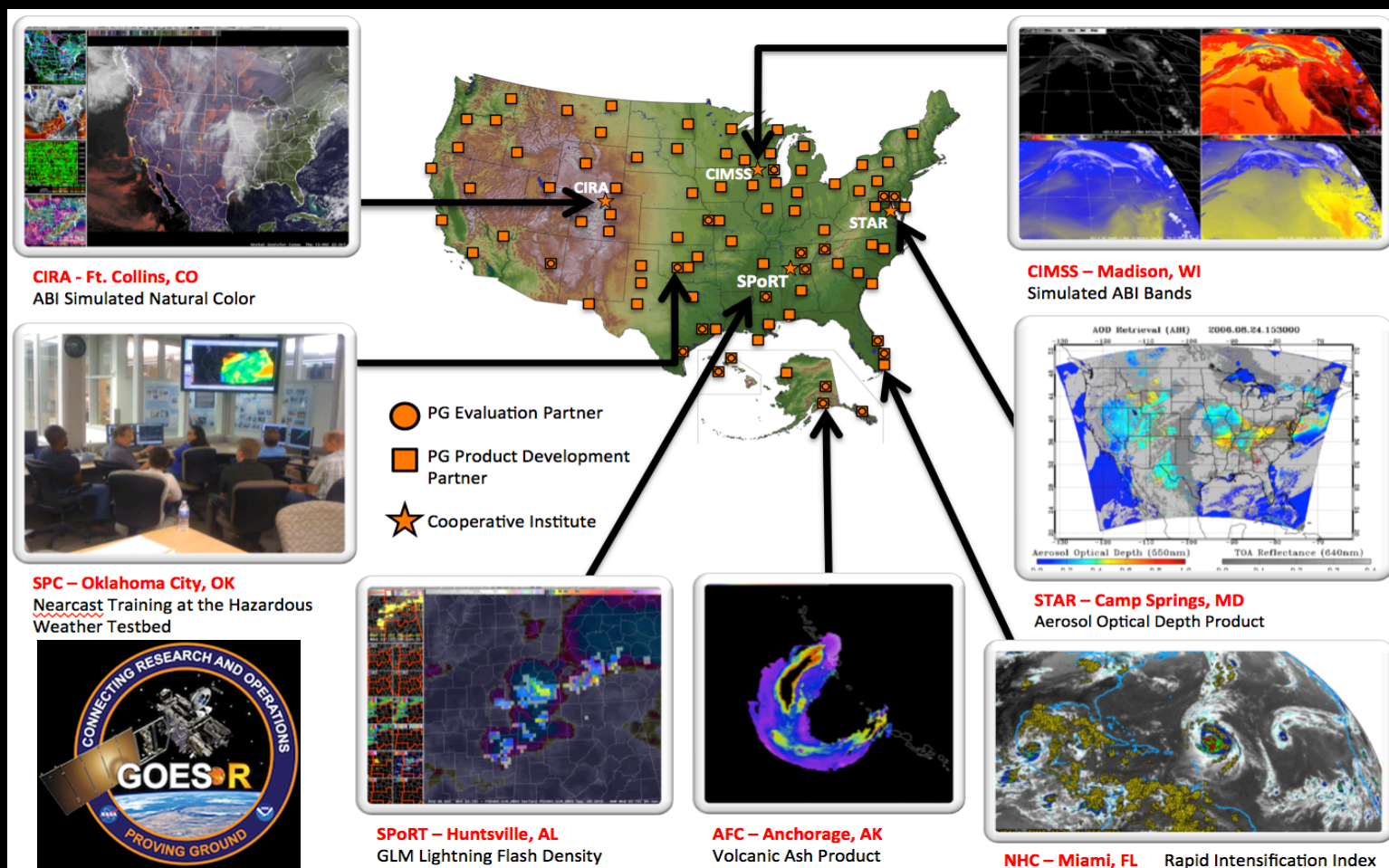
• NHC 2011 Hurricane Season

SAB/OPC/HPC

AC Aviation Testbed and OCONUS Alaska, Pac

GOES-R Spacecraft

Solar Array

Solar Ultraviolet Imager (SUVI)

Magnetometer

Extreme Ultraviolet and X-Ray Irradiance Sensor (EXIS)

Space Environment In-Situ Suite (SEISS)

Geostationary Lightning Mapper (GLM)

Advanced Baseline Imager (ABI)

The GOES-R Proving Ground

- Collaborative effort between the GOES-R Program Office, selected NOAA Cooperative Institutes, NWS forecast offices, NCEP National Centers, NASA SPoRT, JCSDA, and NOAA Testbeds

- Responsible for user readiness testing of GOES-R baseline products and future capabilities prior to launch
  - Proxy and simulated GOES-R products are tested, evaluated, and integrated into operations before launch
  - Satellite Champions at NWS National Centers, Training for users, Prepare for AWIPS/AWIPS-II/N-AWIPS

CIRA - Ft. Collins, CO
ABI Simulated Natural Color

SPC – Oklahoma City, OK
Nearcast Training at the Hazardous Weather Testbed

CIMSS
CIRA
STAR
SPoRT

● PG Evaluation Partner
■ PG Product Development Partner
★ Cooperative Institute

CIMSS – Madison, WI
Simulated ABI Bands

STAR – Camp Springs, MD
Aerosol Optical Depth Product

SPoRT – Huntsville, AL
GLM Lightning Flash Density

AFC – Anchorage, AK
Volcanic Ash Product

NHC – Miami, FL   Rapid Intensification Index

Visiting Scientists: Satellite Champions

NWS Centers	Visiting Scientist/PI	CI	NOAA Host
SPC/HWT	C. Siewert, K. Kuhlman	OU-CIMMS	Russ Schneider, Steve Weiss
OPC, HPC, SAB	Michael Folmer	CICS	J. Sienkiewicz, E. Danaher, J. Kibler
AWC	Amanda Terborg	UW-CIMSS	David Bright
NWS Training Center	Chad Gravelle	UW-CIMSS	John Ogren
Pac Region	Roy Huff	UH-JIMAR	Bill Ward
AK Region	Tom Heinrichs	UAF-CIFAR	Gary Hufford, Carven Scott
Various	Renate Brummer, Steve Miller, Mark DeMaria	STAR/CSU-CIRA	Various
Various	Wayne Feltz, Tim Schmit	STAR/UW-CIMSS	Various
Various	Gary Jedlovec	NASA-SPoRT	Various
SwPC	Steve Hill, Bill Denig	SwPC, NGDC/CIRES	Brent Gordon, Rodney Viereck
NWS HQS	Amy Huff, S. Kondragunta/Ray Hoff	STAR/UMBC	Ivanka Stajner

GOES-R Products

Baseline Products

Advanced Baseline Imager (ABI)

Aerosol Detection (Including Smoke and Dust)
Aerosol Optical Depth (AOD)
Clear Sky Masks
Cloud and Moisture Imagery
Cloud Optical Depth
Cloud Particle Size Distribution
Cloud Top Height
Cloud Top Phase
Cloud Top Pressure
Cloud Top Temperature
Derived Motion Winds
Derived Stability Indices
Downward Shortwave Radiation: Surface
Fire/Hot Spot Characterization
Hurricane Intensity Estimation
Land Surface Temperature (Skin)
Legacy Vertical Moisture Profile
Legacy Vertical Temperature Profile
Radiances
Rainfall Rate/QPE
Reflected Shortwave Radiation: TOA
Sea Surface Temperature (Skin)
Snow Cover
Total Precipitable Water
Volcanic Ash: Detection and Height

Geostationary Lightning Mapper (GLM)

Lightning Detection: Events, Groups & Flashes

Space Environment In-Situ Suite (SEISS)

Energetic Heavy Ions
Magnetospheric Electrons & Protons: Low Energy
Magnetospheric Electrons: Med & High Energy
Magnetospheric Protons: Med & High Energy
Solar and Galactic Protons

Magnetometer (MAG)

Geomagnetic Field

Extreme Ultraviolet and X-ray Irradiance Suite (EXIS)

Solar Flux: EUV
Solar Flux: X-ray Irradiance

Solar Ultraviolet Imager (SUVI)

Solar EUV Imagery

Future Capabilities

Advanced Baseline Imager (ABI)

Absorbed Shortwave Radiation: Surface
Aerosol Particle Size
Aircraft Icing Threat
Cloud Ice Water Path
Cloud Layers/Heights
Cloud Liquid Water
Cloud Type
Convective Initiation
Currents
Currents: Offshore
Downward Longwave Radiation: Surface
Enhanced "V"/Overshooting Top Detection
Flood/Standing Water
Ice Cover
Low Cloud and Fog
Ozone Total
Probability of Rainfall
Rainfall Potential
Sea and Lake Ice: Age
Sea and Lake Ice: Concentration
Sea and Lake Ice: Motion
Snow Depth (Over Plains)
SO_2 Detection
Surface Albedo
Surface Emissivity
Tropopause Folding Turbulence Prediction
Upward Longwave Radiation: Surface
Upward Longwave Radiation: TOA
Vegetation Fraction: Green
Vegetation Index
Visibility

Proving Ground Product Evaluation

The following products are part of current GOES-R Proving Ground demonstrations:

Baseline Products

- Cloud and Moisture Imagery
- Volcanic Ash: Detection and Height
- Hurricane Intensity
- Lightning Detection: Events, Groups & Flashes
- Rainfall Rate/QPE
- Total Precipitable Water
- Fire/Hot Spot Characterization
- Cloud Top Phase
- Cloud Top Height
- Cloud Top Temperature
- Derived Motion Winds
- Aerosol Detection
- Aerosol Optical Depth

Future Capabilities

- Aircraft Icing Threat
- Convective Initiation
- Enhanced "V"/Overshooting Top Detection
- Low Cloud and Fog
- SO_2 Detection

Governance: From PGEB to SDEB

- NWS and NESDIS/GOES-R made changes to existing GOES-R PG governance to better address operational requirements

- Governance changes provided a mechanism for NWS Corporate Priorities to guide both PG and R3 activities.

PGEB and R3 Governance Board
Merged to form the SDEB

| GOES-R Proving Ground Executive Board | GOES-R Risk Reduction Governance | JPSS Proving Ground Executive Board |

Merge

(TBD)
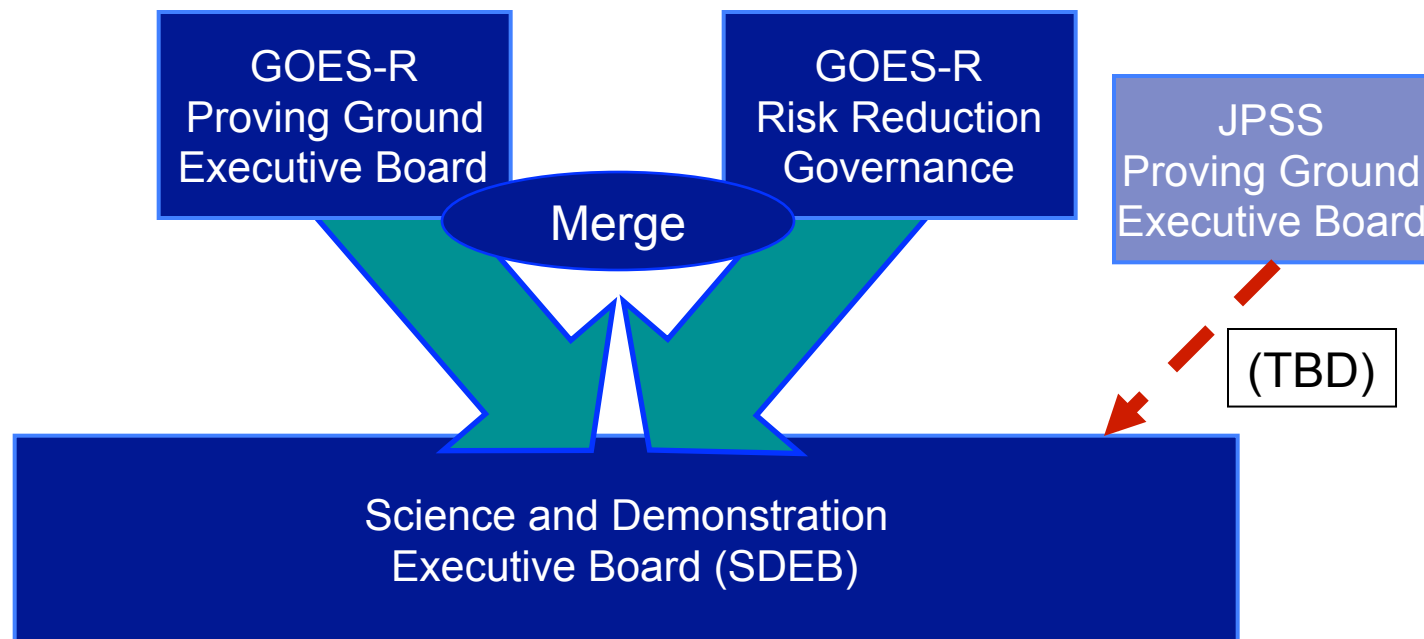
SDEB
Steve Goodman
Jaime Daniels
Jim Gurka
Ingrid Guch
Mike Johnson
Marty Ralph
Jaime Daniels

Science and Demonstration Executive Board (SDEB)

The SDEB:

(1) Oversees future Proving Ground (PG) and Risk Reduction (R3) activities
(2) Is chaired by the GOES-R Program Senior Scientist
(3) Includes membership from NWS, NESDIS, and OAR

Provides guidance to ensure that the science development and demonstration activities are aligned with operational priorities.

SDEB Management and Advisory Structure
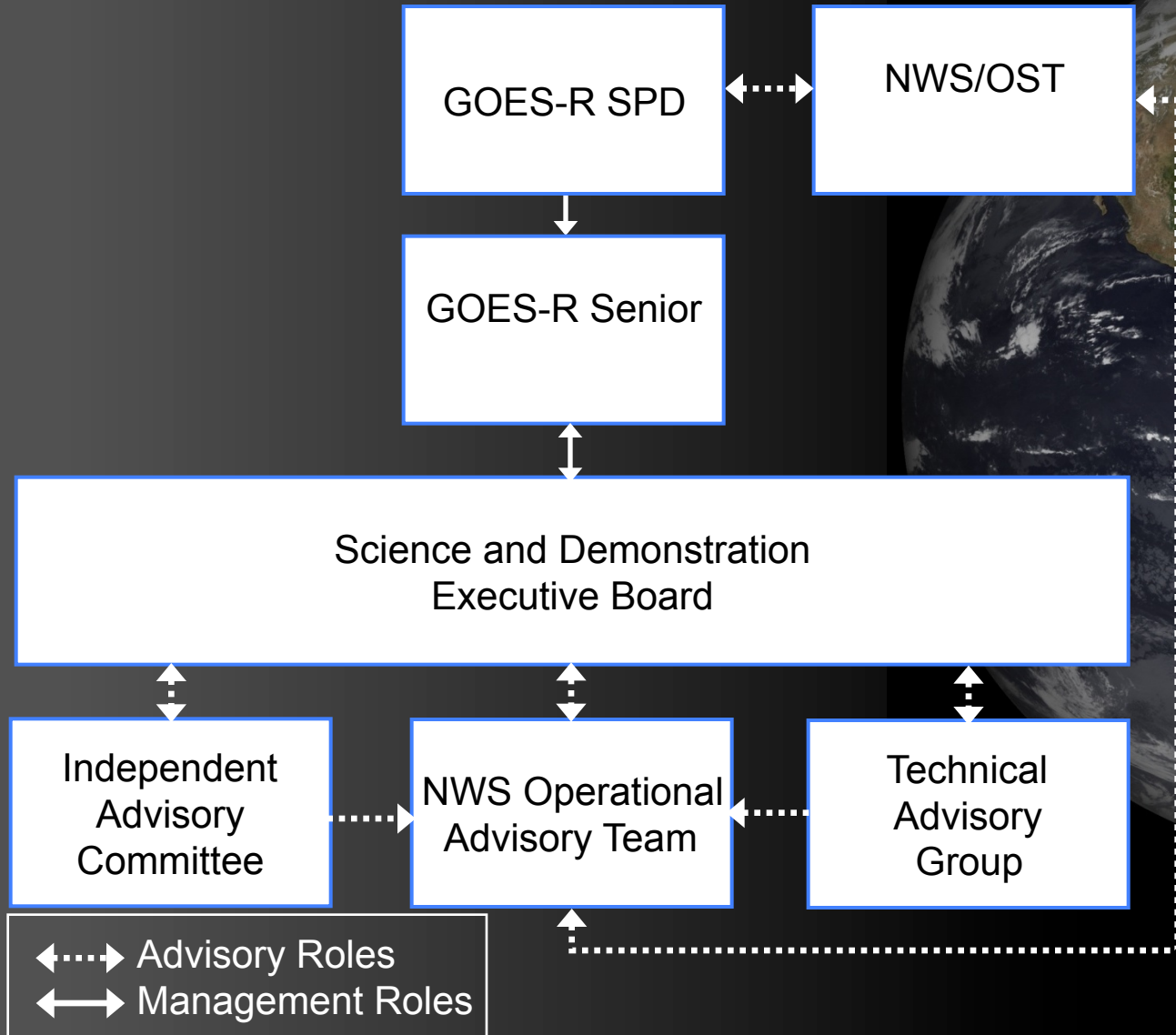
GOES-R PG Partnership with NOAA's Hazardous Weather Testbed
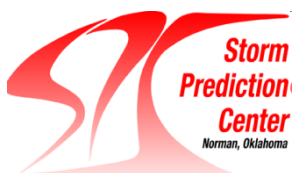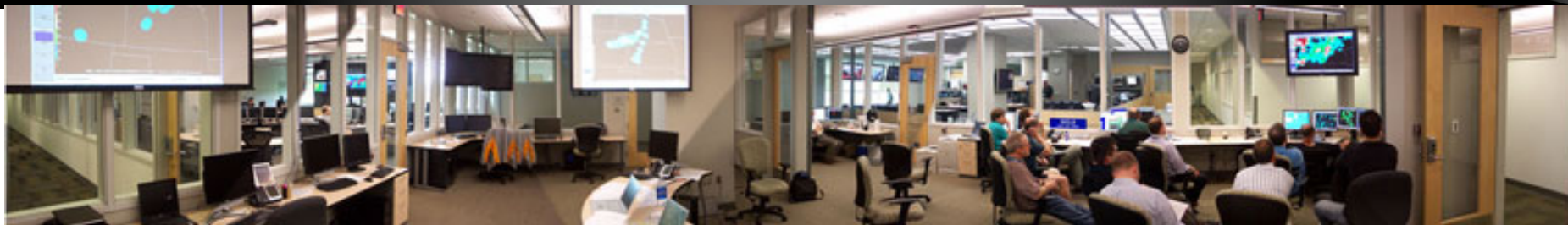
Experimental
Forecast
Program

EFP   EWP

GOES-R PG

Experimental
Warning
Program

*Prediction of hazardous weather events from **a few hours to a week in advance***

*Detection and prediction of hazardous weather events **up to several hours in advance***

HWT 2011 Spring Experiment

Evaluating Products with greatest operational value (24 forecasters May 9 – June 10)

- Nearcasting products
  - Routinely used at all the desks in both the EFP and EWP
  - Did a good job showing where convection is likely and just as important… where it can be ruled out in the next 1-6 hours
- LMA: pseudo GLM products
  - Routinely used in the EWP
  - Extremely useful during warning ops to ID cells with rapid intensification
  - Numerous examples operational value in generating forecasts and warnings and in identifying when 1st cloud to ground flash will occur
- Simulated CMI from NSSL WRF
  - Part of daily routine at the CI desk for model performance evaluation
  - Forecasters impressed with capability to detect low-level moisture pooling and convective instability via band differences

Baseline Product :
Simulated Satellite Imagery (KPPs)

- Simulated using 0Z NSSL-WRF 10-km output
  - 9 non-solar ABI IR bands
  - 24 forecast hours
  - 1-hour time-steps
    - 12 UTC day 1 – 12 UTC day 2
  -
    -
    -
  -

  profiles and band difference products to compare with model forecasts
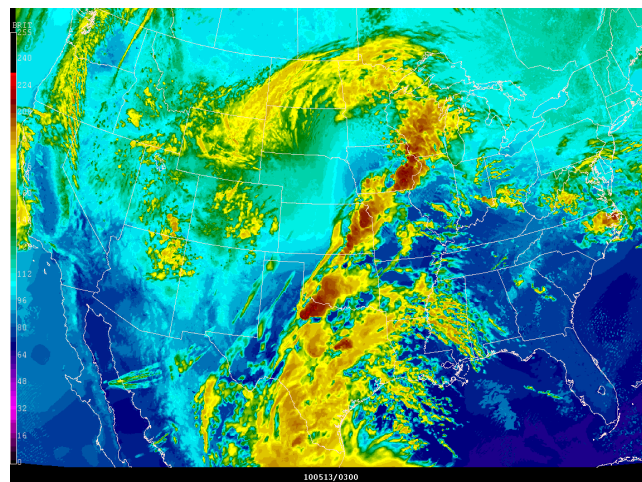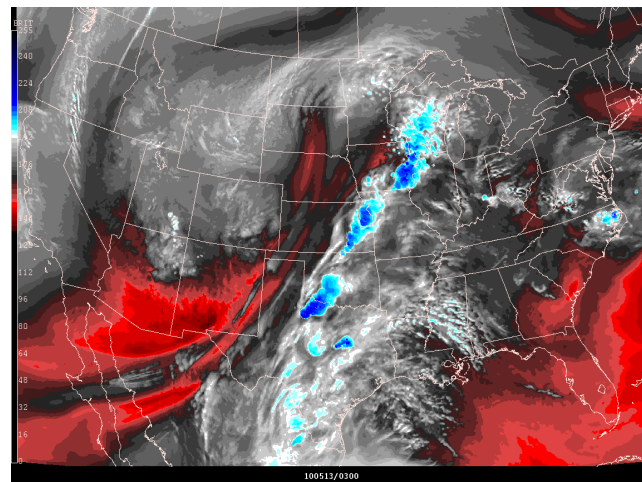
Using the GOES-12 Sounder to Nearcast Severe Weather

http://cimss.ssec.wisc.edu/model/nrc/

Robert Aune (NESDIS) and Ralph Petersen (CIMSS)

The CIMSS Near-casting Model uses hourly GOES Sounder retrievals of layered precipitable water (PW) and equivalent potential temperature (Theta-E) to predict severe weather outbreaks up to *__6 hours in advance!__*

Hourly, multi-layered observations from the GOES Sounder are projected forward in time along Lagrangian trajectories forced by gradient winds. "Trajectory observations" from the previous six hours are retained in the analysis. Destabilization is indicated when theta-E decreases with height.

Limitations:
- Sounder channels support only two layers for near-casting
- Only useful for elevated convection – Sounder can't detect low-level moisture
- Frequent false alarms – Sounder can't detect inversions

One Example of a Successful Near-cast

Low-level Theta-E NearCasts shows warm moist air band moving into far NW Iowa by 2100 UTC.
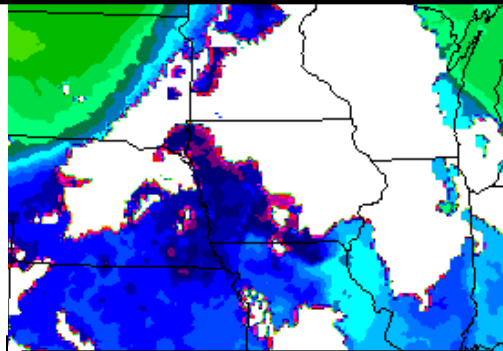
6-hour NearCast for 2100 UTC Low level Theta-E

Vertical Theta-E Differences predict complete convective instability by 2100 UTC.

Severe thunderstorms occurs as predicted!
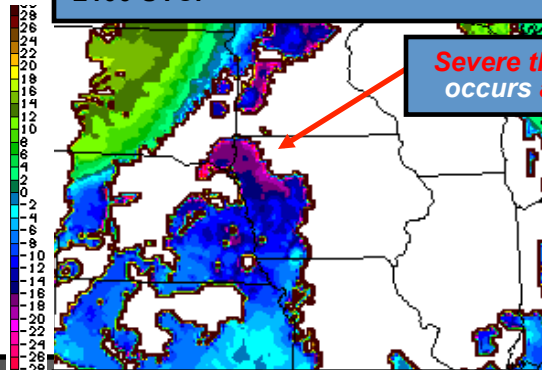
6-hour NearCast for 2100 UTC Low to Mid level Theta-E Differences

NWS Radar Mosaic
Upper Mississippi Valley Sector
1948 UTC 07/09/2009
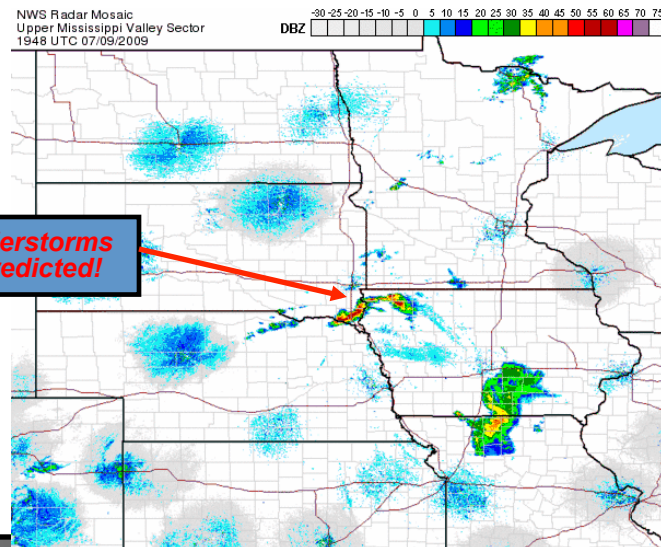
Rapid Development of Convection over NW Iowa between 2000 and 2100 UTC 9 July 2009

# Total Lightning Demonstrations at the GOES-R Proving Ground

- ## Pseudo-GLM
  - Data from ground-based total lightning detection networks
    - Huntsville, AL; Washington, DC; Melbourne, FL; and Norman, OK
  - Raw data sorted into flashes and interpolated to an 8km grid
  - Running 2-minute average

- ## Simulated Lightning Threat
  - Implemented in NSSL-WRF, OU/CAPS ensemble, and High Resolution Rapid Refresh (HRRR)
  - Estimates total lightning from vertical ice content and flux within cloud objects (see McCaul et al., 2009)
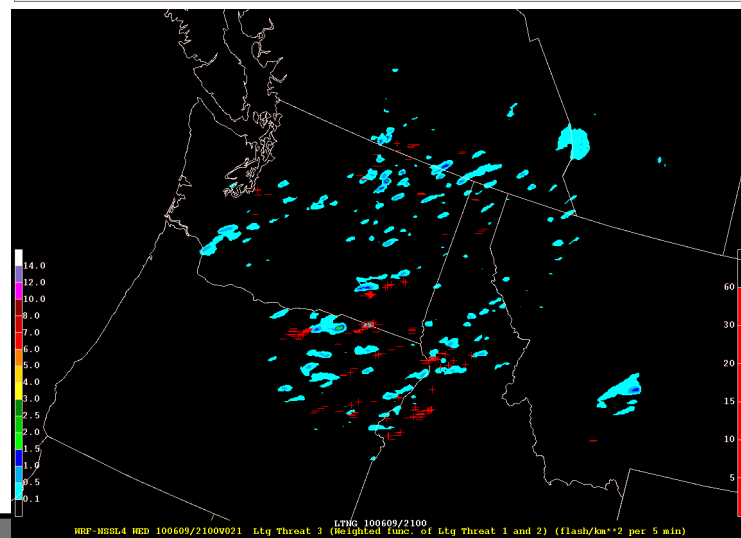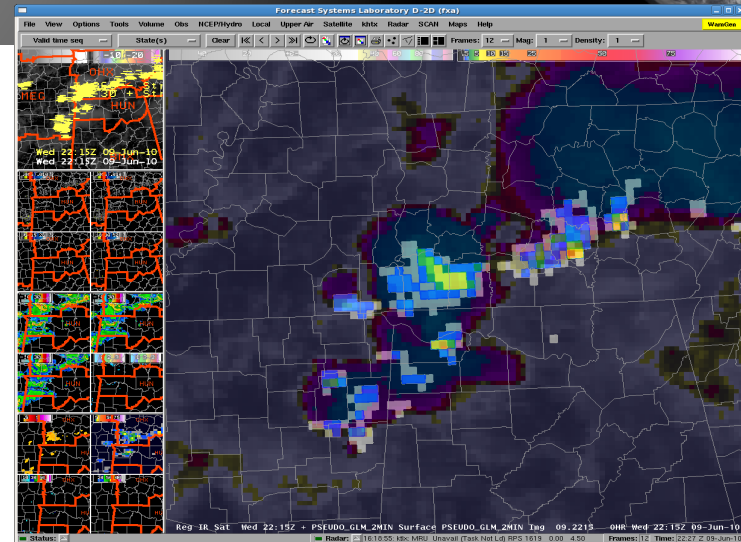
Forecaster Feedback: Lightning Detection

- "The total lightning data is an excellent tool for monitoring convection, I see much promise for such data in the future…"

- "I utilized it as a situational awareness product …the PGLM data gave me more confidence in my warning."

- "Total lightning data preceded the CG network (NLDN) anywhere from 10-40 minutes. I was able to quickly determine when flash rate was significantly increasing, and then compare with satellite and updraft/downdraft parameters for a nice big picture."

- "Coming into the day, I wasn't quite sure when or where to or why to use the data, but after using it. I really think it has a lot of functionality and is useful in warning operations. I look forward to it as a product from the GOES-R."

"We saw several instances where the total lightning was picking up on storms before the AWIPS lightning [NLDN] program picked up on them. One could see the utility of this in the future, bringing with it a potential for lightning statements and potentially lightning based warnings."
**-Pat Spoden (SOO, NWSFO Paducah, KY)**
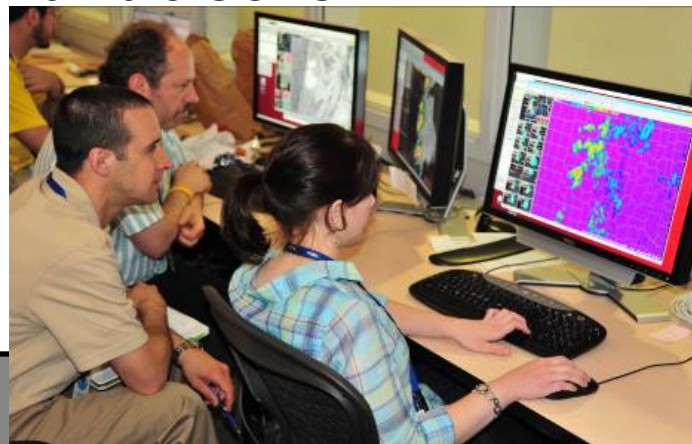
# 2011 NHC Experiment

Products evaluated and user feedback:

- Hurricane Intensity Estimate (HIE)
  - Generated from MSG and GOES-East
  - HIE more responsive in showing intensification compared to ADT
  - Useful in decision to upgrade TD 12 to Katia
- RGB Air Mass Product
  - Generated from MSG and GOES Sounder.
  - Availability in N-AWIPS greatly increased utility
  - Helped Identify extratropical transition of Lee, Irene & Katia
  - Color contrast too subtle in GOES Sounder version
  - May need a limb correction for SEVIRI version
- SAL Product
  - SEVIRI based product: only available via web pages…. needed on N-AWIPS
- SRSO data
  - Valuable around sunrise for storm center location; and A/C recon go – no go decisions
  - Per forecaster recommendation… web site at CIRA with PG SRSO cases for further study
    - http://rammb.cira.colostate.edu/products/srso/

- GOES-R Natural Color Imagery
  - Generated from MODIS…. Problem with image too green at large zenith angles… correction under development
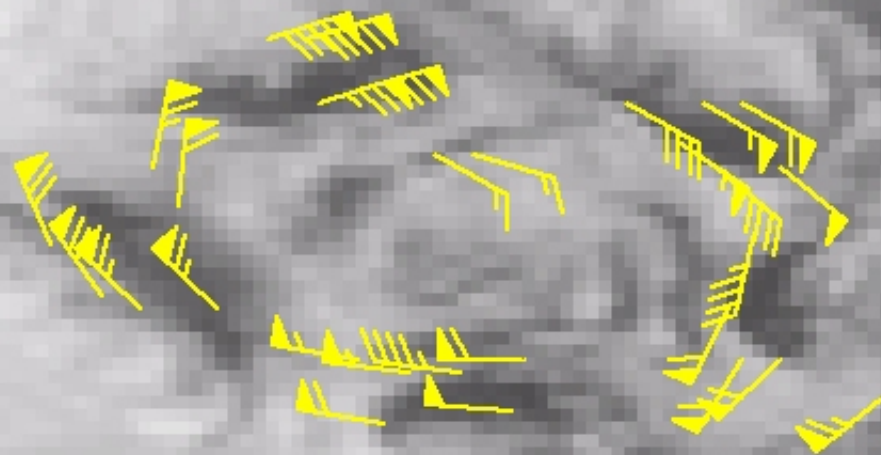
GOES-15: Sample "1-min" imagery
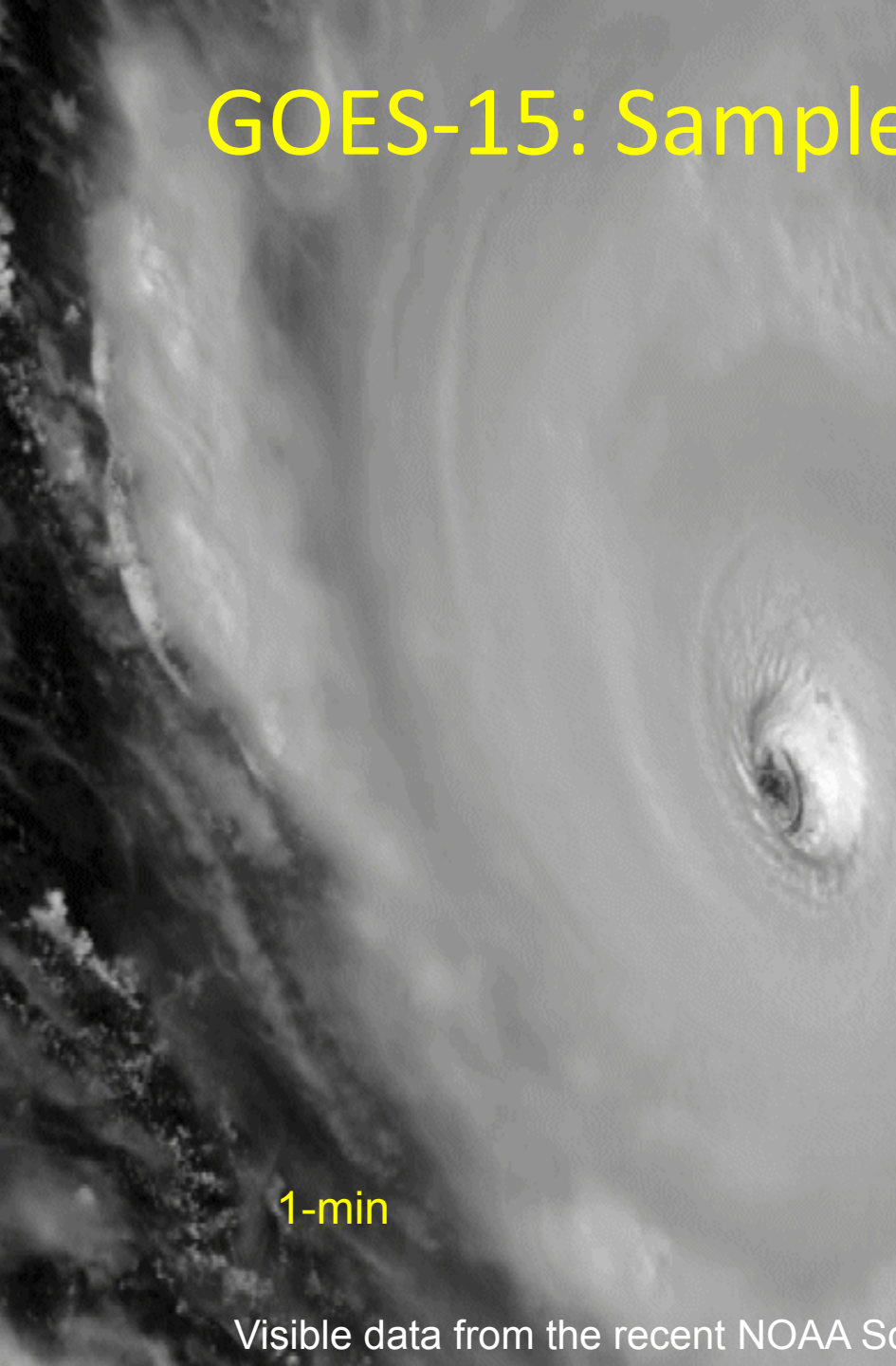
1-min
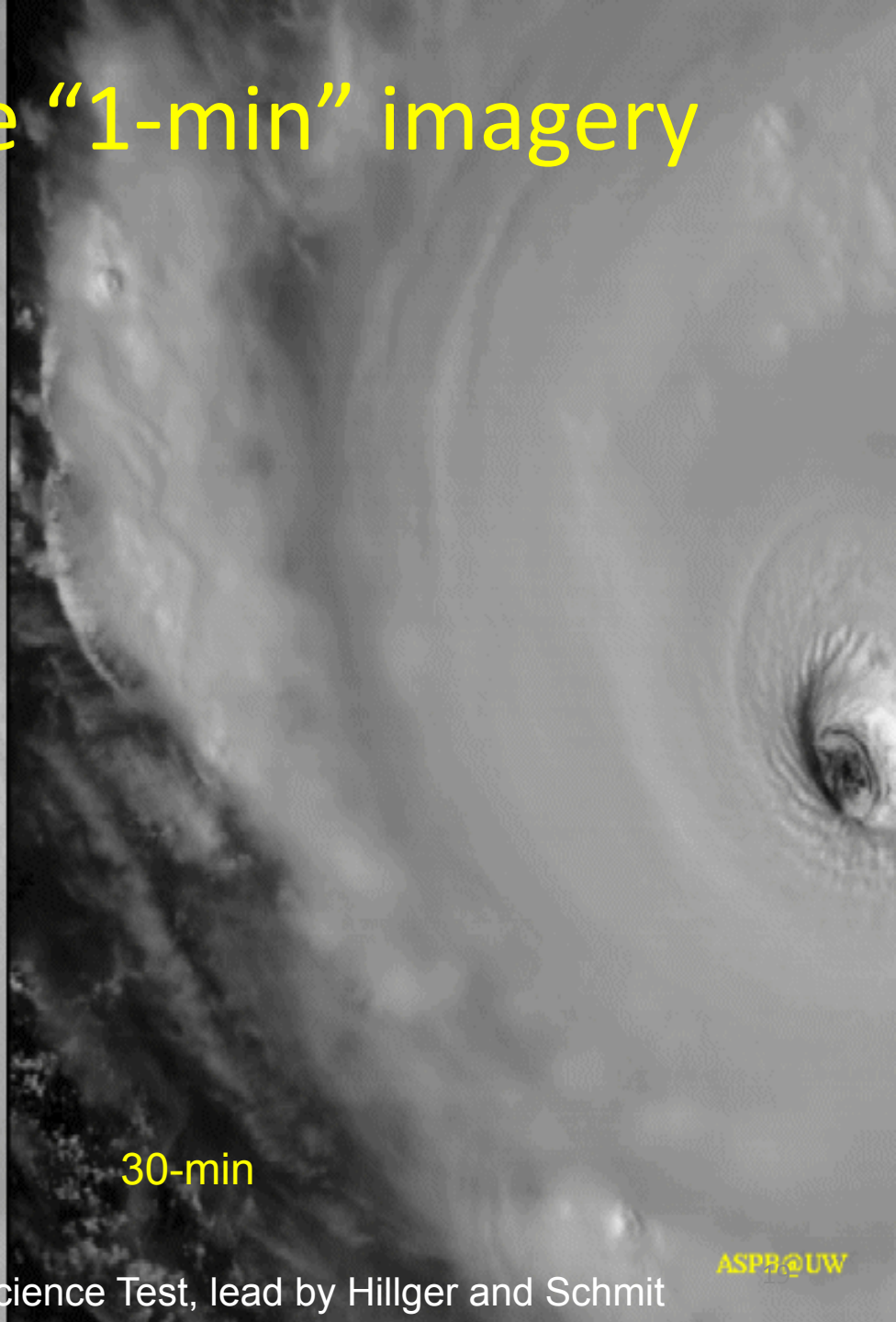
30-min

Visible data from the recent NOAA Science Test, lead by Hillger and Schmit

From C. Velden, UW/CIMSS

GOES-12 SRSO   12 SEP 03   13:07 UTC   HURRICANE ISABEL

Rapid scan (3-min) low-level winds in the hurricane eye

Future Capability:
RGB Air Mass Product

"The RGB airmass and dust products were very useful in showing that the pre-Irene disturbance was going to have dry air issues initially. I think this helped us give the system a low chance of development in the early tropical weather outlooks."

Jack Beven, NHC

Hurricane Irene

110827/1701 SOUNDER AIRMASS
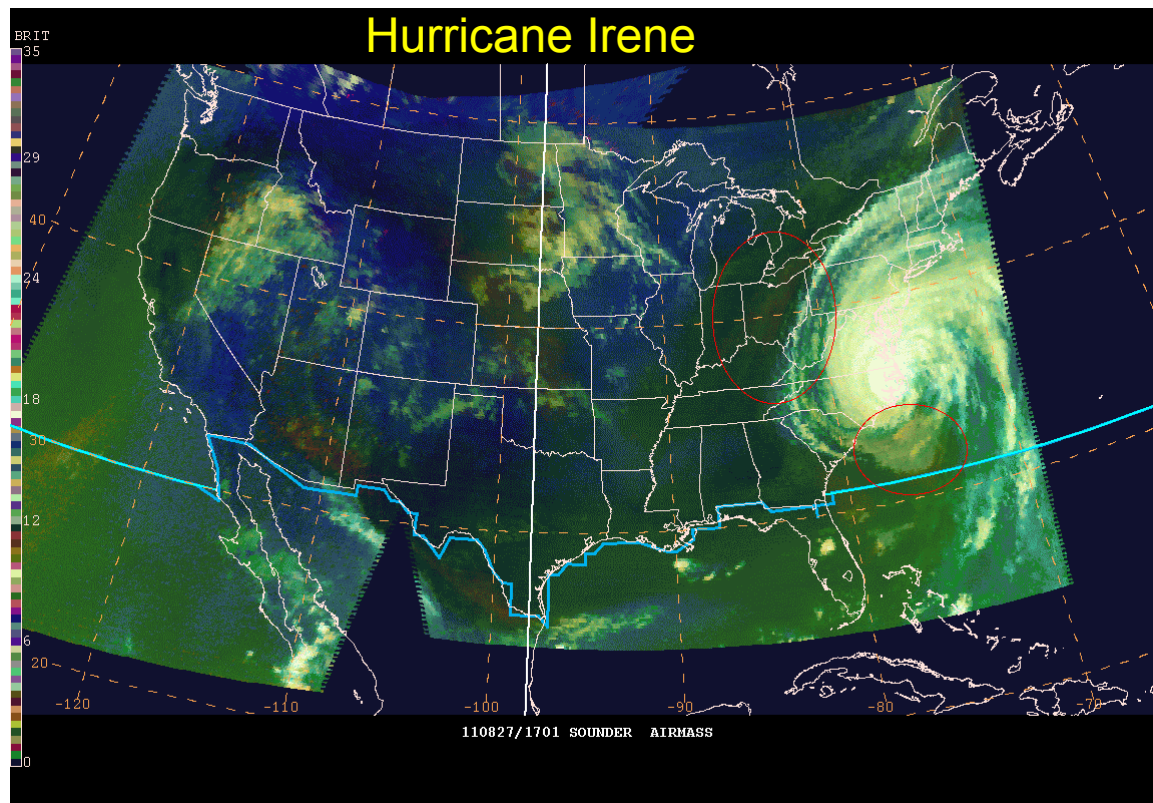
Caption: As the hurricane is approaching Cape Lookout, NC, the GOES sounder shows evidence of synoptic-scale dry air can be seen on the south-southeast side of the circulation (highlighted with a red ellipse). A second circle to the northwest of the storm shows synoptic-scale dry air on the periphery of the storm. This dry air is caught in the southwest inflow channel, effectively cutting off convective development by introducing stably stratified air.

Additional 2012 Demonstrations

- OPC and SAB (Camp Springs MD)
  - Focus on offshore thunderstorms
- High Latitude and Arctic Experiment (Alaska Region)
  - Focus on snow/cloud/ash/aviation
- HPC and SAB (Camp Springs MD)
  - Focus on precipitation/QPF
- Air Quality (UMBC)
  - Focus on aerosol detection
- Pacific Region (Hawaii)
  - Focus on tropical cyclones/heavy rainfall/aviation
- Space Weather (NWS SWPC: Boulder CO)
  - Focus on GOES-R like level 2 products

SAB mention of the GOES-Sounder RGB Air Mass Product for the 4/22/12 Nor'easter
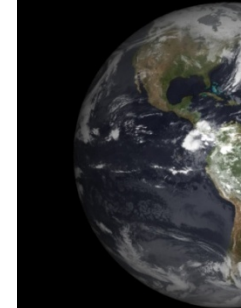
00z 04/20 - 23z 04/23
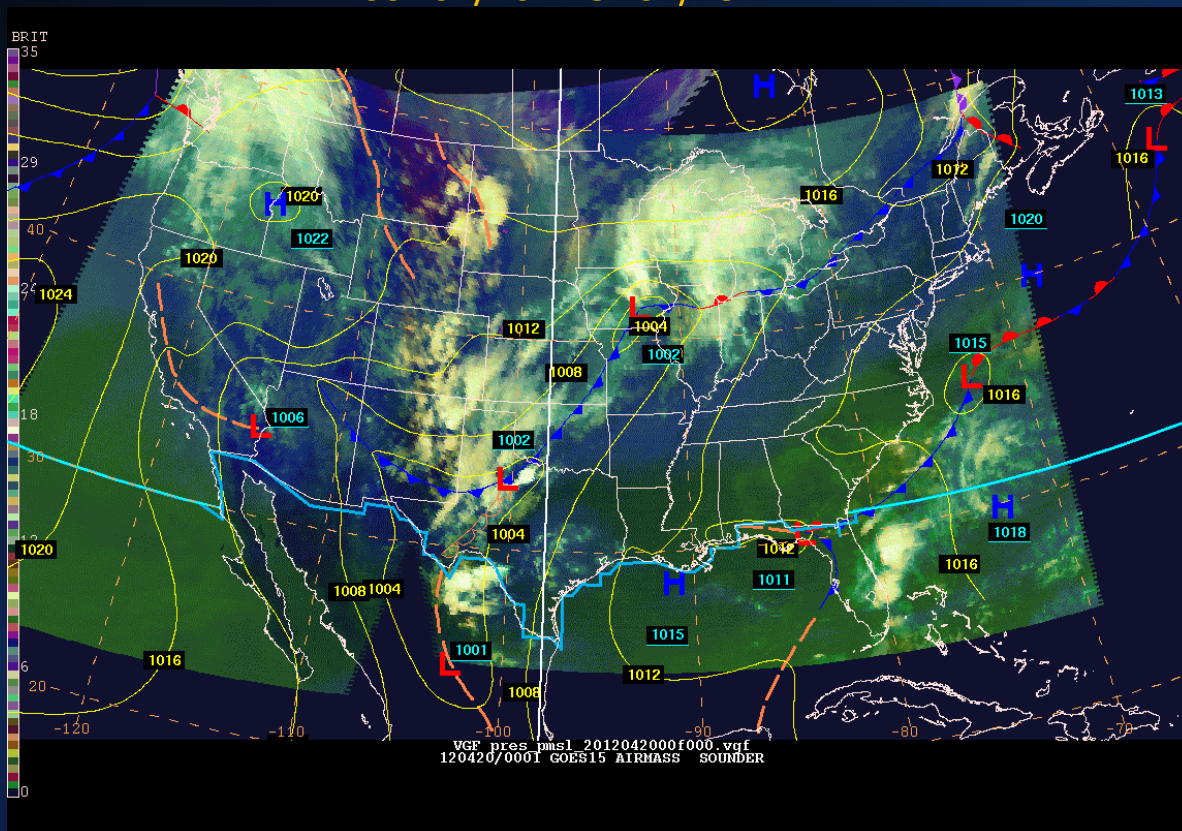
DEVELOPMENTAL GOES RGB IMAGERY REALLY SHOWING THIS EVOLUTION AND RAPID INTENSIFICATION OF NRN STREAM PIECE OF ENERGY WELL THE PAST FEW HRS. THIS EVIDENT BY INTRUSION OF STRATOSPHERIC AIR/DEVELOPMENT OF A STRONG JET OVER ERN MO/SRN IL/KY/TN AND DEVELOPMENT OF COLD POOL OVER WI/MI/IN/NRN IL. MEANWHILE, THESE SAME FEATURES WITH SRN STREAM UL LOW HAVE BECOME LESS DEFINED AND SUGGEST THIS PIECE OF ENERGY MAY BE WEAKENING. SO WOULD EXPECT, NRN STREAM PIECE OF THE PUZZLE TO BECOME MAIN INFLUENCING FACTOR IN WHAT HAPPENS WITH PRECIP/SFC LOW HEADING THROUGH THE NEXT FEW HRS.

- Josh Newhard
NESDIS/OSPO Satellite Analysis Branch

Courtesy of Michael Folmer (CICS Satellite Champion at HPC/OPC/SAB)

Aviation Baseline Product: Volcanic Ash Product Suite

- Chile's Puyehue-Cordón Caulle Volcano erupted on June 4, 2011, forming a tall ash plume above the Andes Mountains

- The GOES-R Proving Ground provides near real-time volcanic ash retrieval products (using Meteosat SEVIRI data as a proxy for the GOES-R Advanced Baseline Imager) to identify a significant volcanic ash plume emerging over the Atlantic Ocean impacting aviation operations with many cancelled flights.

- Similar data was provided by STAR to the London Volcanic Ash Advisory Center (VAAC) during the eruption of Eyjafjallajökull in Iceland in May 2010.
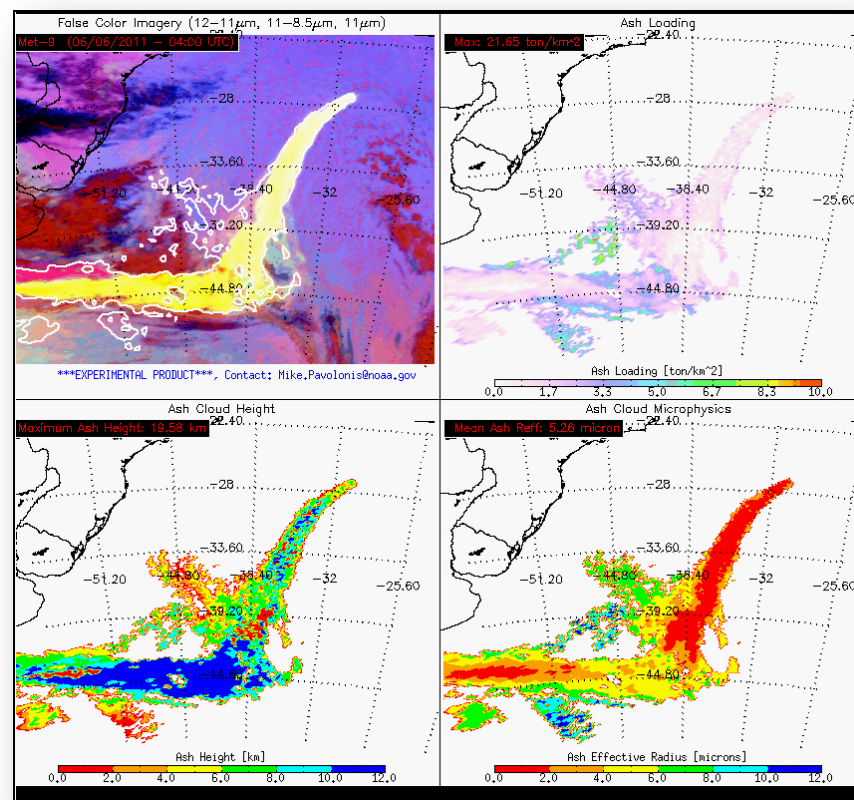
Courtesy, Mike Pavolonis/NESDIS-STAR

GOES-R User Readiness

- Expanded User Community content at **http://www.goes-r.gov/users/user-readiness-overview.html**

- GOES-R Facebook page (**https://www.facebook.com/GOESRsatellite**)

- GOES-R Proving Ground
  - Demonstrations
  - CIMMS, CIRA, SPoRT, HWT blogs

- Visiting Scientist Program

- Forecaster Feedback

- Training and Outreach

- Fact sheets

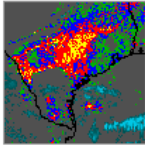- Tri-fold brochure

- User Readiness Plan completed February 2012

Training and Education

Online Training Modules

- GOES-R: Benefits of Next-Generation Environmental Monitoring (COMET)
- GOES-R 101
- Satellite Hydrology and Meteorology for Forecasters (SHyMet)
- SPoRT product training modules
- Commerce Learning Center

Printed Materials

- GOES-R Fact Sheets (17)
- GOES-R Tri-fold

Outreach Projects (with NWSFOs)

- COMET will reach out to the GOES-R Proving Ground Partners and connect them with university faculty to use current and prototype data products for the purpose of building a bridge from products that are currently available to those that will become available when GOES-R is launched.

GOES-R Visiting Scientist Program

10 Visiting Scientists have been selected in 2012 for 1-4 week visits to exchange ideas and initiate/continue collaborations applicable to their current research with other scientists and end users

Scientist exchanges among NWS Centers and regions, NOAA Cooperative Institutes, national laboratories, and other partners

Continuing cooperation with EUMETSAT, Environment Canada, and others

GOES-R Science Team members participated in the Convection Working Group meeting in Prague, Czech Republic, March 27-30, 2012

Future Plans:
2012 And Beyond

- Continue to apply lessons learned to incorporate new improvements each year. Example:

  - From HWT Spring Experiment… obvious that forecaster application of new products improves with additional training. In 2012 forecasters will have access to satellite training material prior to arrival in Norman.

- Demonstrate products and decision aids in NOAA Testbeds, NCEP Centers, WFOs, and the NWS Proving Ground at Training Center

- Transition from Warning Related Products to remaining Baseline Products, Day 2 Future Capability, Decision Aids, Decision Support Services

- Continue to develop, demonstrate, and test as part of decision support services

- Enhanced JPSS, international, and broadcaster community collaboration

Lightning Detection

Total Lightning Flash Rate Tendency Relative to Tornado

Modest Lightning — 1236 UTC
Lightning Surge — 1246 UTC
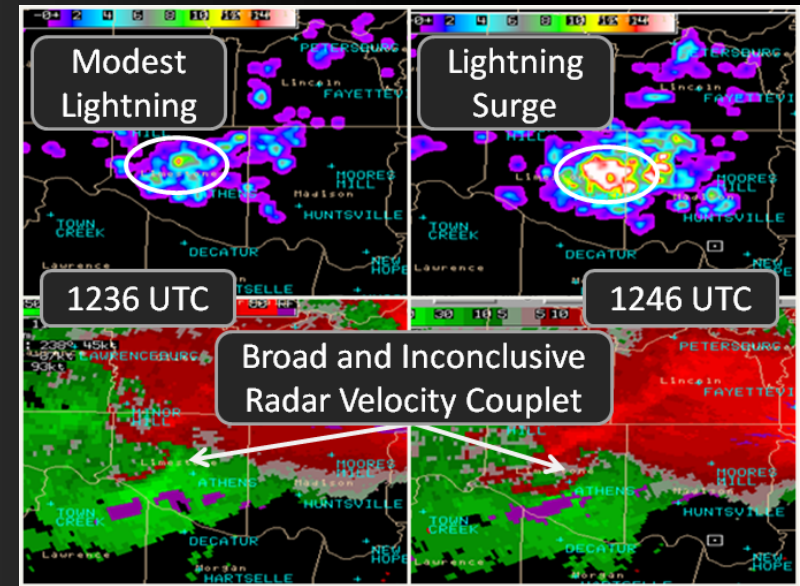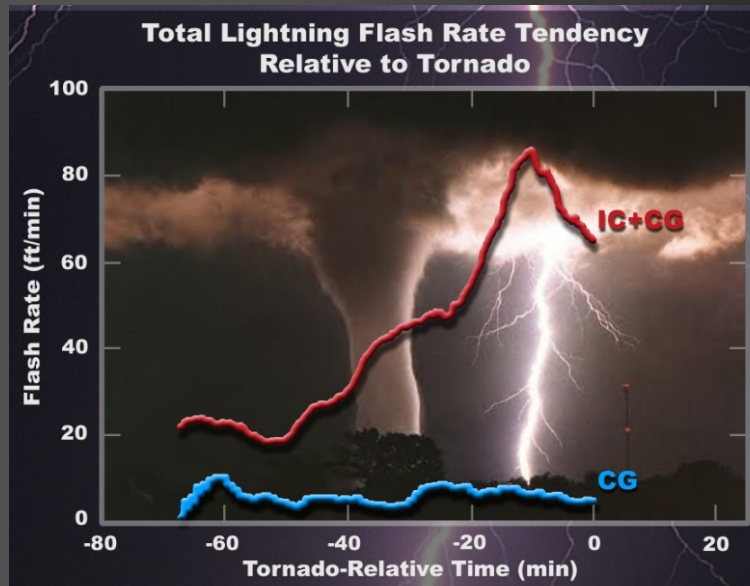Broad and Inconclusive Radar Velocity Couplet

TABLE 3. Skill scores and average lead times using the sample set of 711 thunderstorms for both total lightning and CG lightning, correlating trends in lightning to severe weather.

	POD	FAR	CSI	HSS	lead time (all)	lead time (tornado)
Total lightning	79%	36%	55%	0.71	20.65 mins	21.32 mins

National Average for Tornado warning lead-time is only 14 minutes, High FAR

An operational demonstration of the total lightning algorithm at the Hazardous Weather Testbed (at request of NWS) began in early April and is currently in progress.

Summary

- GOES-R Proving Ground provides mechanism to:

    - Involve CIs, AWG, National Centers, NOAA Testbeds and WFOs in user readiness

    - Get prototype GOES-R products in hands of forecasters

    - Keep lines of communication open between developers and forecasters

    - Allow end user to have say in final product, how it is displayed and integrated into operations

- Proving Ground continues to grow and plans are in place for 2012 and beyond.

- For GOES-R to be a success, forecasters must be able to use GOES-R products on Day 1!

Backup
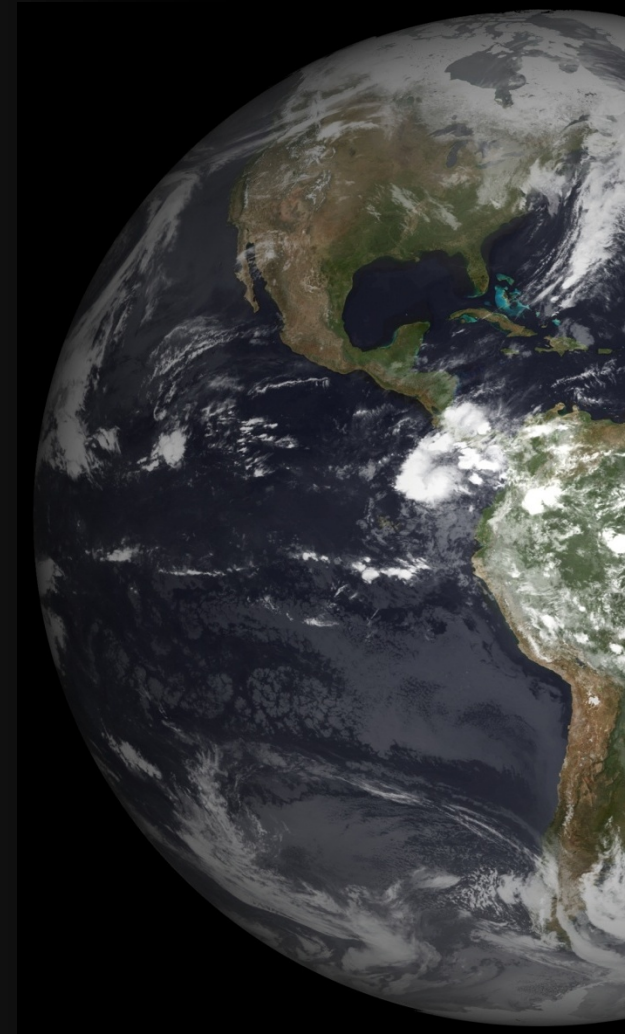
NOAA Satellite Conference

for Direct Readout, GOES/POES, and GOES-R/JPSS Users

GOALS:

Enhance user access, reception and readiness for data, technology, and applications from current and future environmental satellite constellations

Improve use of satellite data by leveraging advances in science, applications development, data fusion, and visualization

Promote interaction, coordination, and communication between and among environmental satellite programs

http://satelliteconferences.noaa.gov/Miami2013